FINENESS RELATIONSHIP OF RAW WOOL, TOP, NOIL, AND PERCENT NOILAGE

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FINENESS RELATIONSHIP OF RAW WOOL, TOP, NOIL, AND PERCENT NOILAGE

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SUMMARY

A study was conducted on the fineness relationship of raw wool, wool top, noils and percent noilage, and directed toward the development of micron specifications for grades of raw wool. The work was carried out on 173 lots of wool made up of 134 lots of domestic and 39 lots of foreign, representing grades from 80s through 36s. The wools were French or Noble combed and processed into wool top by 19 different mills, from clips in 1948 through 1953, for the purpose of determining fineness changes and the relationship of fineness between card sliver (raw wool), top, noil, and percent noilage.

The data in this study showed the fineness of top, card sliver, noil, and percent noilage to be highly correlated ($R = 0.99$).

The average fiber diameter of the card sliver was more directly related to the average diameter of the top ($r_{12.34} = 0.88$) than either fiber diameter of noil ($r_{13.24} = 0.28$) or percent noilage ($r_{14.23} = 0.20$).

The relative net effect on the multiple correlation of the different contributing variables was accounted for by the average fiber diameter of card sliver showing 86.23 percent; average diameter of noil 14.46 percent; and percent noilage -0.69 percent.

It appears from the data studied that the fineness of raw wool is the most satisfactory single measure for estimating the fineness of top.

From the simple linear regression equations the fineness of top may be estimated from the fineness of card sliver, and conversely the average fineness of raw wool needed to produce a top of a given fineness may be calculated.

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INTRODUCTION

Wool fineness is considered the most important single quality characteristic upon which utility and value of apparel wool is assessed. It is the basis of grading or classifying wool for market, and its influence is paramount in spinning and manufacture.

In the grades and standards research program of the U. S. Department of Agriculture, fineness specifications for diameter of fiber and fiber distribution have been developed for the official standards of the United States for grades of wool top (6) 2/. Standards for grades of wool based on fineness or diameter, represented by physical samples were officially promulgated (4). In an effort to define grades of wool on a dimensional basis and since fineness does vary between grades, and since in many cases wool is sorted before being processed, a logical approach toward the developing of measurement specifications for fineness of grease wool seemed to be that of relating grease wool fineness attributes to the specifications already developed for wool top.

Results of preliminary investigations of this nature on five lots, reported by the U. S. Department of Agriculture, (5) showed the average fiber diameter of top to be coarser than that of the card sliver being combed, or that of the noils removed by combing. In a report by Pohle et al (3), on the relationship of fineness in wool top, noil, card sliver, and grease wool on 24 lots, results showed the fineness of the top to be coarser in each instance than the fineness of the noil, the card sliver, or the grease wool. The report also indicated that there appeared to be no significant difference between the fineness of card sliver and grease wool for all lots tested. Johnston et al (2) investigated the use of cores of wool drawn from bales to determine fineness and fineness variability of raw wool. Three lots of graded grease wool were used. Samples of carded wool were obtained during commercial carding and used as controls for fineness of grease wool for the lots. The comparison of the fineness of the card sliver with the fineness of the core sample showed that the difference was not significant.

More extensive research in this field has subsequently been conducted to determine what changes may occur in fineness through the flow of processing from raw wool to wool top. The purpose of these investigations was first, to determine to what extent the fineness of the raw wool going into the lot, and the fineness and

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2/ Underscored numbers in parentheses refer to Literature Cited, page 9.

amount of noils being removed by combing affected the fineness of the resultant top; and secondly, to find a satisfactory single measure or combination of measures which could be applied to raw wool to estimate the fineness of the top. Through these investigations basic information has been obtained that has been used in the development of proposed revisions of present standards adding micron specifications for grades of raw wool (8).

MATERIALS AND METHODS

The wools of 173 lots which had been combed into wool top were used in this study. The tops produced ranged in grade from 80s through 36s. Preliminary treatment of the lots varied: some were graded and sorted before combing; others were graded, with offsort portions of the fleeces removed; others were merely graded before combing. Of the lots 134 were of domestic or United States origin, and 39 were of foreign origin, having been produced in the following countries: Argentina, Australia, Iraq, New Zealand, and Uruguay. The wools were grown during the years 1948 through 1953.

Processing by 19 different mills is represented in the study, the lots being either Noble or French combed. At the various stages of processing, samples of card sliver, top, and noil of each lot were drawn. The card sliver, which is wool that has merely been cleaned and carded into loose sliver form and usually without twist, was used to represent the raw wool. Ten samples of this sliver, each approximately 24 inches long, five samples of top sliver, each 36 inches long, and a quantity of noil of approximately 1 pound were obtained for each lot.

Measurement studies on the samples were made in the Department's wool standards laboratory. The measurement technique followed closely the procedures described in the Department's method of test for grades of wool top (7). The number of fibers measured was that which would result in a standard error of the mean between 0.20 and 0.25 micron. Noilage figures, used along with the measurement results in the analysis and expressed as the customary percentage of noil on the total top and noil, were reported for each lot by the mills.

Correlation and regression methods described by Ferber (1) were used in the analysis of the data.

RESULTS

The mean values for average fiber diameter of wool top, card sliver, noil, and for average percent noilage were calculated according to grade of top produced. These data are presented in Table 1.

Table 1.- Mean values for average fiber diameter of wool top, card sliver, noil, and the average percent noilage, by grade of top for 173 lots

Grade of Top	Number of Lots	Average Fiber Diameter			Percent Noilage
		Wool Top	Card Sliver	Noil	
		Microns	Microns	Microns	
80's	2	18.5	17.9	17.0	14.9
70's	9	20.6	20.3	19.2	11.6
64's	25	22.0	21.5	20.0	12.2
62's	21	23.4	22.9	21.0	13.6
60's	20	24.8	24.3	22.0	10.2
58's	17	26.5	25.7	23.0	9.2
56's	11	27.7	26.9	23.5	9.9
54's	15	29.3	28.5	24.9	10.8
50's	14	30.7	29.8	25.8	9.2
48's	7	32.3	31.4	26.7	7.6
46's	11	34.3	33.5	27.7	11.2
44's	9	36.3	35.5	29.3	9.1
40's	11	37.7	37.0	31.0	6.4
36's	1	39.1	38.7	32.0	6.6

The multiple regression line computed from the original data was: $X_1 = -1.4360 + 0.9890X_2 + 0.2159X_3 + 0.0243X_4$, where X_1 = fineness of top; X_2 = fineness of card sliver; X_3 = fineness of noil; and X_4 = percent noilage.

The standard error of the regression coefficients was calculated to be for $X_2 = 0.0392$, $X_3 = 0.0565$, and $X_4 = 0.0093$.

The standard deviation of the regression line was 0.4558 micron.

The coefficient of multiple determination was 0.9924 and the coefficient of multiple correlation 0.99.

Partial correlation coefficients are presented in Table 2.

Table 2.- Partial correlation coefficients

Order of correlation coefficient	Correlation between X_1 [1/] and		
	X_2	X_3	X_4
Zero order	$r_{12} = 0.99$	$r_{13} = 0.98$	$r_{14} = -0.36$
First order	$r_{12.3} = 0.87$	$r_{13.2} = 0.29$	$r_{14.2} = 0.20$
	$r_{12.4} = 0.99$	$r_{13.4} = 0.98$	$r_{14.3} = -0.01$
Second order	$r_{12.34} = 0.88$	$r_{13.24} = 0.28$	$r_{14.23} = 0.20$

Order of correlation coefficient	Correlation between X_2 and		Correlation between X_3 and X_4
	X_3	X_4	
Zero order	$r_{23} = 0.98$	$r_{24} = -0.38$	$r_{34} = -0.36$
First order	$r_{23.4} = 0.98$	$r_{24.3} = -0.13$	$r_{34.2} = 0.06$

1/ X_1 fineness of top
X_2 fineness of card sliver
X_3 fineness of noil
X_4 percent noilage

Direct and indirect effect of the independent variable on the multiple correlation are presented in Table 3.

Table 3.- Direct and indirect effects of the independent variables on the multiple correlation

Effect	Ave. Diam. of Card Sliver X_2	Ave. Diam. of Noil X_3	Percent Noil X_4	Total
Direct	0.738720	0.021222	0.000360	0.760302
Indirect				
X_2 and X_3	0.123254	0.123254	--	0.246508
X_2 and X_4	-0.006190	--	-0.006190	-0.012380
X_3 and X_4	--	-0.001007	-0.001007	-0.002014
Total indirect	0.117064	0.122247	-0.007197	0.232114
Net effect	0.855784	0.143469	-0.006837	0.992416
	86.23%	14.46%	-0.69%	

DISCUSSION

The data show that the average fiber diameter of wool top is greater than the average fiber diameter of the carded wool from which the top is combed. This difference is attributed primarily to the removal of noils during combing.

The spread in average fiber diameter between the carded wool and wool top increased as the raw wool became coarser or lower in grade.

The average fiber diameter of the noil is less than the average fiber diameter of either the top from which it is combed or the carded wool being combed.

The multiple regression analysis explains 99 percent of the variance between the average fiber diameter of the top samples.

The over-all relationship between the fineness of top and the fineness of raw wool, and the fineness of noil and the percentage noil is very high (R = 0.99).

The second-order correlation coefficients (Table 2) between the average fiber diameter of top and card sliver ($r_{12.34} = 0.88$) show the average fiber diameter of card sliver to be more directly related to average fiber diameter of top, than either the average fiber diameter of noil ($r_{13.24} = 0.28$) or percent noilage ($r_{14.23} = 0.20$).

The direct effect of the average fiber diameter of card sliver (Table 3) contributes approximately three-fourths of the value of the coefficient of multiple determination, whereas the net effect of percent noilage on the multiple correlation is almost negligible. Percentagewise the relative net effect of each independent variable is as follows: average fiber diameter of card sliver 86.23 percent; average fiber diameter of noil 14.46 percent; and percent noilage 0.69 percent.

The average fiber diameter of card sliver and noil are strongly correlated ($r_{23} = 0.98$) and ($r_{23.4} = 0.98$).

The high correlation between average fiber diameter of card sliver and noil indicates that for most purposes one or the other is sufficient. The negative net effect of percent noilage signifies that it is acting to reduce the over-all relationship.

In view of these findings it appears from the analyses and from the practical application that the fineness of the raw wool is the most satisfactory single measure for estimating the fineness of top.

A scatter diagram and regression line showing the fineness relationship of wool top and card sliver or raw wool are presented in Figure 1. For all practical purposes the estimated fineness of top can be estimated from the fineness of card sliver using the simple linear regression equation: $Yc = 0.1921 + 1.0171X$ where Yc = estimated fineness of top and X = fineness of card sliver.

Conversely the average fineness of raw wool needed to produce a top of a given fineness may be calculated from the following equation: $Yc = 0.0442 + 0.9747X$ where Yc = estimated fineness of raw wool and X = fineness of top.

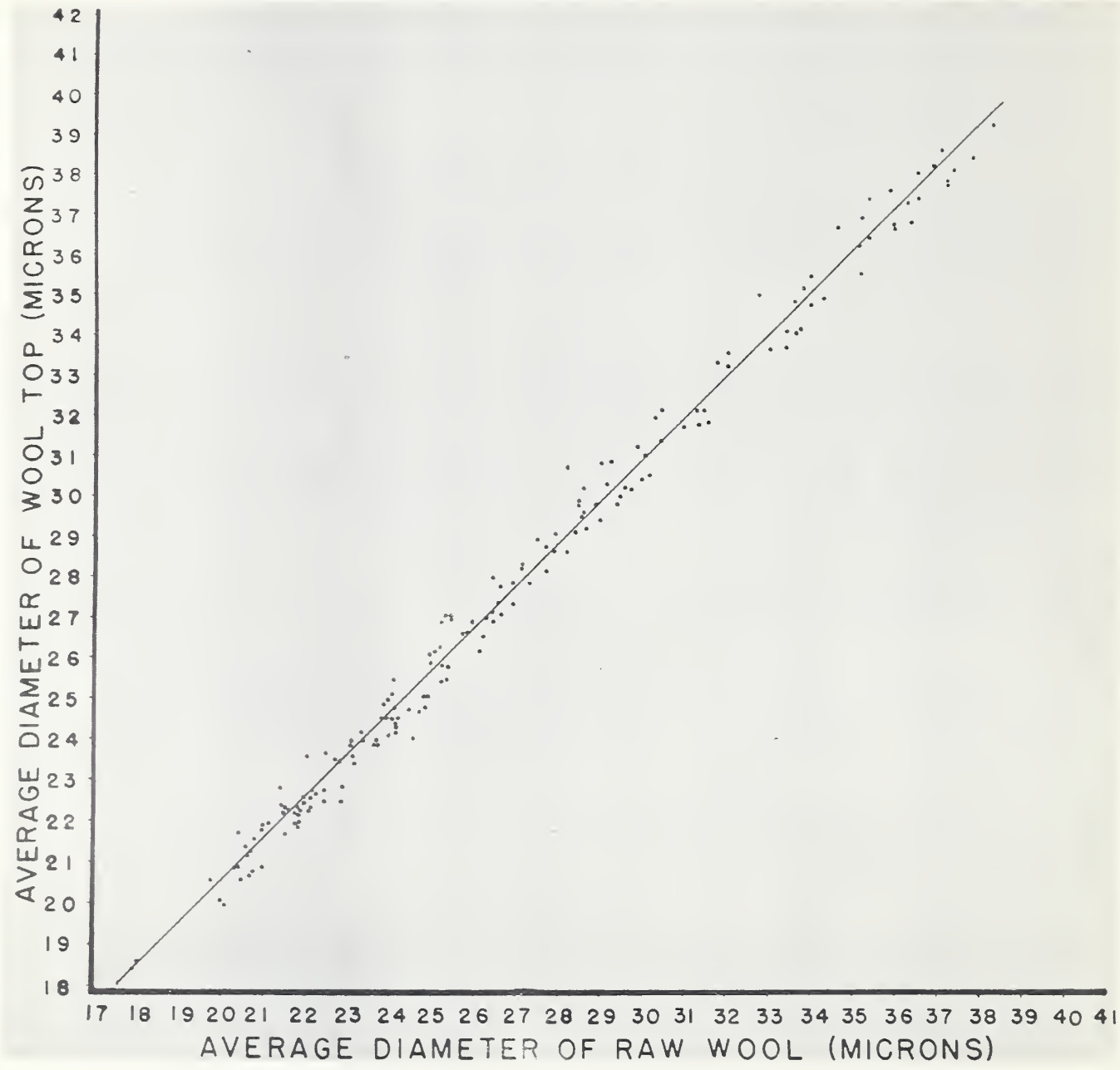

Figure 1.- Scatter diagram and regression line showing the fineness relationship of wool top and raw wool.

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